Analysis of Impregnable MANET routing protocols

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Abstract— *Mobile Ad Hoc Network (MANET) is an infrastructure less network comprising of mobile nodes which dynamically form a network without interference of any centralized administration. Frequently changing network topology demands for an efficient dynamic routing protocol. The differences in protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying node mobility. The mobile nodes in MANET serve as routers and deliver data from a source to its destination. In MANET architectural design routing algorithms play a vital role. This paper deals with the comparison of two broad classification of MANET routing protocols considering their performance as a vital study parameter. The Performance analysis of these two types of routing protocols is done here. This paper also compares Packet Drop Ratio, throughput and end-to-end delay of the protocol under study, with and without considering encryption technique being used. Shift AODV is AODV with encryption technique employed.*

Keywords— *MANET, proactive routing, reactive routing, AODV, DSR*

I. INTRODUCTION

Wireless networks are of mainly two types: Structured networks and Ad-hoc networks. In structured network the mobile nodes are free to move while communicating with other in the network and the base stations are fixed [1].

In Ad-hoc networks there are no fixed base stations as in structured networks. Each mobile node in Ad-hoc network acts as a router which is capable of configuring itself. Each mobile node is also capable of sending and receiving data. The topology of such type of network changes rapidly [1]. In this type of network no constraint is imposed on mobility of intermediate nodes [1]. As soon as there is link breakage the new path to the destination need to be discovered.

Routing protocols are responsible for establishing path between the source and the destination. It is also responsible for maintaining path between two nodes until the communication ceases [2].

Mobile Ad Hoc network also have the potential to establish communication networks in emergency situations like search and rescue operations, military and police operations. MANET can also be used in home and enterprise networking, conferences, m-governance and many more [2].

This paper is organized into following sections. Section II reviews the routing protocols and their classification. Section III briefs about the related work in the area of routing protocols in MANET. Section IV throws light into the comparison of reactive routing protocols like AODV and DSR and also compares the performance of AODV with and without employing encryption technique and presents the discussions and Section V concludes the comparison of Routing protocols.

II. ROUTING PROTOCOLS

Routing protocols are responsible for establishing the optimum path between two nodes wishing to communicate. The path optimality may be in terms of distance or in terms of number of hops. Out of multiple paths available from a source to destination, it is the responsibility of routing protocol to find optimum one to carryout communication [2].

Optimality in terms of distance states that, the path to destination is shortest and optimality in terms of hops, states that the minimum number of hops are incurred for a packet to reach the destination. Many routing protocols were developed for this purpose and in Mobile Ad-Hoc Networks and are traditionally classified as Unicast and Multicast routing protocols.

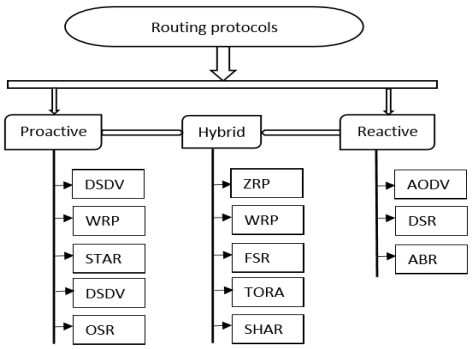

Fig. 1. Classification of Routing Protocols

Further the Unicast routing protocols are broadly categorized as uniform and non-uniform. Uniform routing is either topology based or destination based. Further these are classified as Proactive routing protocols, Reactive routing protocols and Hybrid routing protocols which is depicted in Fig. 1

A. *Proactive Routing Protocols*

Proactive routing protocols [1] are table driven routing protocols and are either destination based or topology based. Nodes using proactive routing protocols maintain routing table(s), which contain information about each and every node residing in that particular network [5]. The information in the routing table is upgraded over time so that each node in the network has a clear view of the recent structure of the network. Proactive protocols work efficiently for lesser number of nodes in network, as the node count in the MANET increases Proactive Protocol efficiency gradually decreases, since they need to update node entries in routing table of each and every node in the network, which creates additional routing overhead [4]. The merit of Proactive Routing protocols is that routes are pre calculated and stored. They are readily available as and when needed. However the overhead of maintaining the precalculated routes increase with the increase in node count. Few of the prominent Proactive Routing protocols are Hierarchical State Routing, Global State Routing and Destination Sequence Distance Vector.

B. *Reactive Routing Protocols*

Reactive routing protocols do not maintain a pre calculated routes between nodes in MANET, but route from a source node to its destination is established when necessary or on-demand. Until communication between the nodes is in progress the established route remains valid. The merit of Reactive Routing protocols is that they are memory efficient and have lesser routing overhead [9].Nevertheless route acquisition latency [1] becomes the limiting factor for this class of protocols. Few of the remarkable Reactive routing protocols are Dynamic Source Routing (DSR), Ad hoc On-demand Distance Vector Routing (AODV), Temporary Ordered Routing Protocol (TORA) [7].

This paper deals with the comparison between Proactive and Reactive Routing Protocols and also different types of Reactive protocols are compared considering various performance metrics.

C. *Hybrid Routing Protocols*

Hybrid routing protocols [3] attempt to exploit the reduced control traffic overhead from proactive protocol class and reducing the route discovery delays from reactive protocol class by maintaining routing table [1]. Zone Routing Protocol (ZRP) [1] is a typical example for Hybrid Routing Protocols.

III. RELATED WORK

Yuxia Bai . et.al [1], provided performance comparison and Evaluation of the Proactive and Reactive Routing Protocols for MANETs including AODV, DSR and DSDV. Their results concluded that AODV algorithm of the reactive type performs better in terms of throughput and average end-to-end delay, while the DSR of reactive type is a little better among the routing algorithms in terms of packet delivery ratio. As the size of the network increases, the reactive protocols, especially the AODV protocol, become dominant in all performance categories, while the influence of the packet size is insignificant.

Nitin Arora and Suresh Kumar. et.al [2], discussed the analysis of routing protocols and their functionality in MANET. The protocols selected for analyzing behavior and comparing them include OLSR, DSR, and ZRP. Different scenarios have been considered in MANET for comparing the routing efficiency of these protocols. It has been concluded that reactive routing protocols AODV and DSR are suited for applications where throughput are very critical. ZRP and OLSR being the location based protocols need sufficient time to establish route discovery and route maintenance. Hence for large range mobile applications these are best suited.

Salim El Khediri et. al [3],did a comparative study on the strengths and weaknesses of MANET routing based on various factors including the average delay occurred in transmitting a packet, energy efficiency, throughput and Packet delivery fraction, for the rapidly emerging wireless networks. This study guides researchers in integrating features of the solution of various protocols and create a successful mobile sensors scenario for their applications.

Ashok. M. Kanthe et. al [4], studied the performance of routing protocol and came with a theorem that says performance depends on the factors and scenario like location of the nodes, speed of the nodes, number of connections of nodes and traffic in between nodes. These routing protocols are compared in terms of throughput, packet drop rate and end-to-end delay. They concluded as, AODV performs better for 80 nodes and DSR performs better for 20 nodes. Hence the AODV protocol is scalable than DSR in terms of network capacity and node count.

Xiaoyan Wei et. Al [5], stated that the trend of communication development is broadband, mobile and intelligent. Personal communication is the highest goal of human communication. Routing protocols of Ad hoc network have been a hot areas of research for several years. But it is complicated and still need long-term effort and exploration to achieve satisfactory routing algorithm and mechanism.

IV. RESULTS AND DISCUSSION

To evaluate the performance of routing protocols, different quantitative metrics can be used . Quantitative metrics that can be used for this purpose are Average end to end delay(AEED), Throughput, Jitter, First Packet Received, Last Packet Received, Total Bytes Received, Packet Delivery Ratio(PDR), Normalized Routing Load and Total Packet Received are a few to list.

A. *Comparison between Proactive and Reactive Routing Protocols*

The comparative study between proactive and reactive routing protocols are tabulated in Table I. These protocols are compared considering the performance metrics like Packet Delivery ratio (PDR), throughput and average end to end delay (AEED) [10].

From Table I, it is easy to conclude that performance of the two major routing protocols is competitive when the network size is relatively small (5 nodes), however as the size of the network increases (10 and 30 nodes), reactive routing protocols

(especially the AODV routing protocol) becomes dominant in all the performance categories. On the other hand, packet size plays a non-crucial role in the comparison.

TABLE I. COMPARITIVE ANALYSIS OF PROACTIVE AND REACTIVE PROTOCOLS[1]

NO OF NODES	STUDY PARAMETERS	PROACTIVE PROTOCOLS	REACTIVE PROTOCOLS
5	THROUGHPUT(IN BITS/SEC)	418.968	403.741
	PDR (IN%)	82.43	72.42
	AEED (IN MS)	0.1478	0.1499
10	THROUGHPUT(IN BITS/SEC)	416.333	419.222
	PDR (IN %)	81.91	82.47
	AEED(IN MS)	0.1479	0.1479
30	THROUGHPUT(IN BITS/SEC)	416.027	419.05
	PDR (IN %)	81.89	82.84
	AEED(IN MS)	0.1499	0.1482

B. Simulation Results for AODV

Results of simulating AODV protocol considering 20 nodes where node 5 is source and node 15 the destination is depicted in fig.2 below.

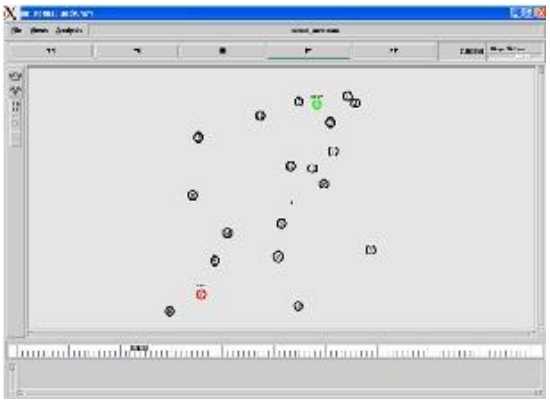

Fig. 2. Simulating AODV protocol

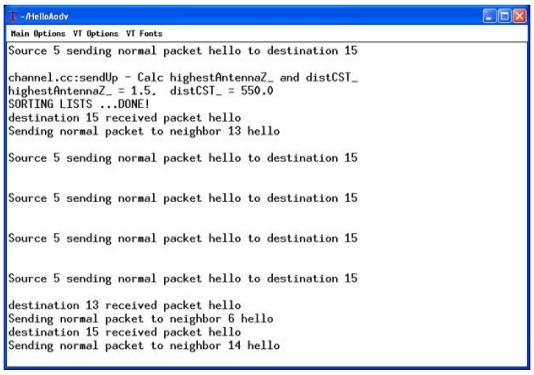

Fig. 3. Transmission of data using AODV protocol

In fig.3 data is sent from source node to destination via neighboring nodes. Whenever network topology changes, distance between source and destination nodes will also vary.

Fig.4, Fig.5 and Fig.6 depicts the PDR graph, Throughput and Energy consumption respectively for the above mentioned network criterion which uses AODV protocol.

In Fig.4, x axis represents number of nodes and y axis represents packet delivery ratio and in Fig.5 x axis represents number of nodes and y axis represents throughput.

Fig. 4. PDR Graph considering AODV Routing protocol

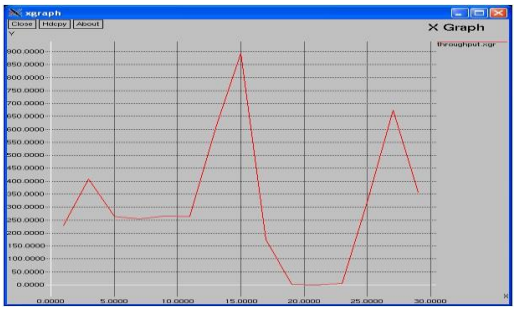

Fig. 5. Throughput considering AODV Routing protocol

In Fig.6, x axis represents number of nodes and y axis represents Energy Consumption by the nodes.

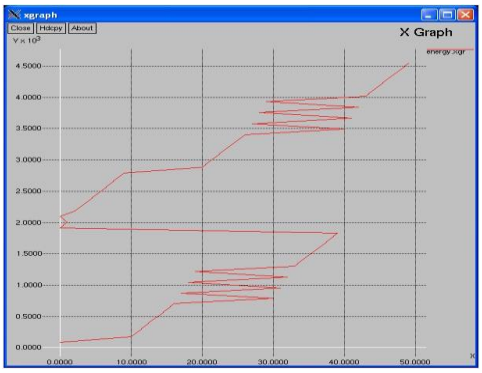

Fig. 6. Energy Graph considering AODV Routing protocol

C. *Simulation Results for AODV using Shift Cipher for Encryption*

Fig.7 represents securing data transmission in AODV using shift Cipher method [11]. Here the data is transmitted from node 5 to node 15 through node 13. The shift key value used here is 2.

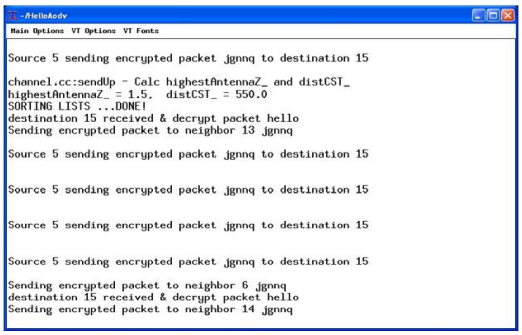

Fig. 7. Securing data transmitted through AODV

D. *Comparison between AODV and Shift AODV Protocols*

Fig.8 represents Packet delay for data transmission in AODV and measured packet delay in normal AODV is 0.160 milliseconds and Packet delay for data transmission in Shift AODV is 0.360 milliseconds. Comparatively the delay in Shift AODV is slightly higher than AODV.

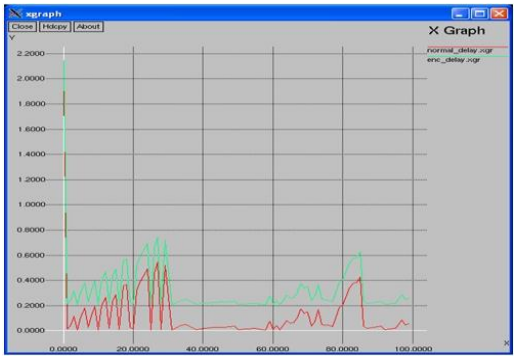

Fig. 8. X graph for Packet Delay

In Fig.8 x-axis represents no of packets and here total 100 packets are considered and y-axis represents delay for that packet. Red line illustrates normal delay and green line illustrates encryption delay.

Fig. 9. X graph for Throughput

In Fig.9 x-axis represents time and y-axis represents throughput at that point of time in terms of successful delivery of packets per time unit. Comparatively the Throughput in Shift AODV is slightly lower than the normal AODV.

Fig. 10. X graph for Data Transmission rate

In fig.10 x-axis represents time of simulation and y-axis represents transmission rate at that point of time for both normal and encrypted AODV

E. *Comparison between AODV and DSR Protocols*

The analysis of Simulation results of Proactive routing protocols and their Survey [1] infers that the Proactive routing protocols work efficiently for MANET with only few nodes and is best suited for MANET applications where the node's memory capacity and routing table maintenance is not a limitation. Nevertheless for MANET applications where the motes have limitations like petty memory capacity and difficult to maintain routing tables, Reactive protocols are best suited. Here AODV is compared with DSR protocol. Also AODV is simulated with and without considering encryption technique like Caesar Cipher or Shift Cipher

In general analysis of AODV Protocol and its Simulation studies show that, as the packet size increased, packet delivery

ratio, throughput and average end-to-end delay also increased for all routing protocols in MANETs. This analysis was done with varying number of nodes like 5, 10, 20 and 30 nodes and the results are depicted graphically using figure 6, figure 7 and figure 8 respectively.

- Comparing **throughput** of different reactive routing protocols, the DSR protocol and AODV are very competitive.
- AODV performs the best when the **number of nodes** and **packet size** are increased. The performance of DSR protocol is comparatively not that good when certain applications are considered.
- The **average end-to-end delay** in AODV becomes better or more competitive as the number of nodes increase.

The comparative study between AODV and DSR routing protocols considering varying number of nodes in MANET are as tabulated in Table II.

Figure.11 depicts a comparative study of AODV and DSR protocols with respect to throughput, considering varying number of nodes in MANET. X axis represents number of nodes and Y axis represents Data delivery in bits per second.

TABLE II. COMPARATIVE ANALYSIS OF DSR AND AODV PROTOCOLS

NODES	PARAMETERS	DSR PROTOCOLS	AODV PROTOCOLS
25	THROUGHPUT(IN BITS/SEC)	3600	3800
	PDR (IN %)	98	98
	AEED(IN SEC)	0.009	0.009
50	THROUGHPUT(IN BITS/SEC)	3700	3900
	PDR (IN %)	90	95
	AEED(IN SEC)	3700	3900
100	THRUGHPUT(IN BITS/SEC)	4000	3800
	PDR (IN %)	90	88
	AEED((IN SEC)	0.012	0.005

Figure.12 depicts a comparative study of AODV and DSR protocols with respect to average end to end delay, considering varying number of nodes in MANET. X axis represents number of nodes and Y axis represents time delay in seconds.

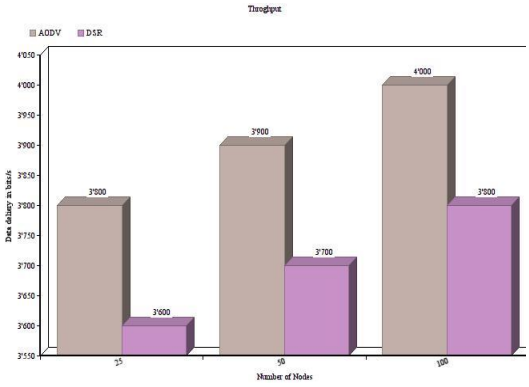

Fig. 11. Throughput Comparison for AODV and DSR

Figure.13 depicts a comparative study of AODV and DSR protocols with respect to Packet Delivery Ratio, considering varying number of nodes in MANET. X axis represents number of nodes and Y axis represents Data delivery in terms of percentage.

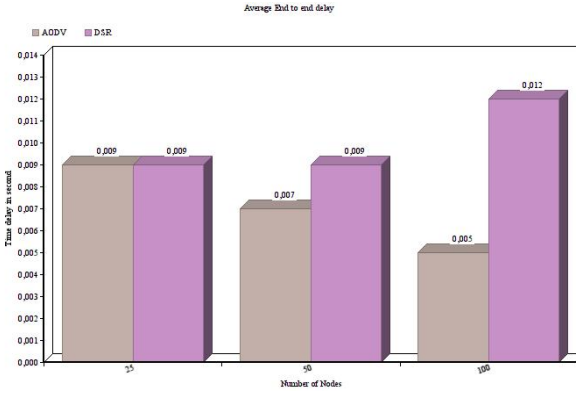

Fig. 12. Average end to end delay Comparison for AODV and DSR

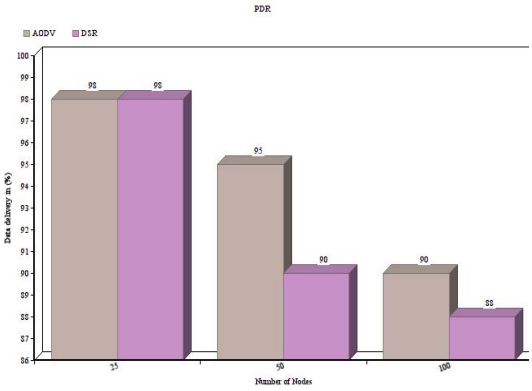

Fig. 13. Packet Delivery Ratio Comparison for AODV and DSR

V. CONCLUSION AND FUTURE SCOPE

MANET's reactive routing protocol, AODV, has been simulated and evaluated in this paper with and without considering implementation of encryption techniques. The two prominent types of MANET routing protocols, proactive and reactive types, are compared and analyzed based on survey of

various simulation setups. Comparative analysis and test results demonstrated that the reactive protocol AODV performs better in terms of throughput and average end-to-end delay, while the DSR of the reactive type is better among the routing protocols in terms of packet delivery ratio. As the size of the network increases, the reactive protocols (especially the AODV routing protocols) become dominant in all performance categories, while the influence of the packet size is insignificant. This work throws light into understanding the performance of the most widely accepted routing protocols of homogeneous MANET.

This work can be extended by implementing other encryption algorithms in AODV to secure the data transmission. The performance of the routing protocols in heterogeneous and real world MANET application is a challenge in near future.

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